U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, DC 20591

March 31, 2022

The Honorable Maria Cantwell
Chair
Committee on Commerce, Science, and Transportation
United States Senate
Washington, DC 20510

Dear Chair Cantwell:

In Section 337 of the FAA Reauthorization Act of 2018 (Pub. L. 115-254, "the Act"), Congress directed the agency to review, with stakeholders, the evacuation certification of transport-category aircraft used in air transportation, and report the results to Congress. The required report is enclosed.

In support of the agency's compliance with Section 337 of the Act, the FAA chartered the Emergency Evacuation Standards Aviation Rulemaking (ARC), which met between October 2019 and May 2020. The ARC included dozens of aviation stakeholders, including the National Transportation Safety Board (NTSB), the European Union Aviation Safety Agency, FlyersRights, the Allied Pilots Association, and the Association of Flight Attendants. The ARC reviewed nearly 300 real-world evacuation events that occurred over the previous decade. The ARC found the overall level of safety in emergency evacuations to be very high, but made 27 recommendations to the FAA related to how the safety of such evacuations could be improved.

Additionally, in Section 577 of the Act, Congress directed the agency to issue, after notice and comment, such rules as necessary for the safety of passengers with regard to the minimum dimensions of passenger seats. To gather data in furtherance of the agency's implementation of Section 577, and in further compliance with Section 337, the FAA in late 2019 to early 2020 conducted simulated emergency evacuations at the Civil Aerospace Medical Institute (CAMI). In these tests, seat size and spacing did not adversely affect the success of emergency evacuations. CAMI recommended, however, that the FAA continue to monitor anthropometric issues related to passenger seats. The CAMI study is included as an appendix to the report required by Section 337. FAA recognizes that the CAMI tests relied on able-bodied adult subjects under age 60, consistent with regulatory and ethical standards for human testing. As a result, they provide useful, but not necessarily definitive information, regarding the effects of seat dimensions on safe evacuations for all populations.

In furtherance of the agency's implementation of Section 577 and continuous review of aviation safety data and information, the FAA plans to seek public comment on the issue of minimum seat dimensions, inviting the public to provide technical information and other comments on the minimum seat dimensions necessary for passenger safety. As part of this invitation for public comment, the enclosed report to Congress along with the ARC report and the CAMI study will be placed into the docket for review. This invitation will include the opportunity to provide information regarding minimum seat dimensions necessary for passenger safety as they pertain to children, individuals over 60, and individuals with disabilities, because the CAMI study did not include participants from those communities. The FAA will then consider the information submitted by the public in making a final determination, pursuant to Section 577, regarding the minimum seat dimensions that are necessary to ensure passenger safety.

FAA will continue its oversight of the issue and looks forward to working with the committee on increasing aviation safety.

A similar response has been sent to the Ranking Member of the Senate Committee on Commerce, Science and Transportation and the Chair and Ranking Member of the House Committee on Transportation and Infrastructure.

Sincerely,

Steve Dickson
Administrator

Enclosures

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800 Independence Ave., S.W.
Washington, DC 20591

March 31, 2022

The Honorable Roger F. Wicker
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate
Washington, DC 20510

Dear Ranking Member Wicker:

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Steve Dickson
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800 Independence Ave., S.W.
Washington, DC 20591

March 31, 2022

The Honorable Peter A. DeFazio
Chair
Committee on Transportation and Infrastructure
House of Representatives
Washington, DC 20515

Dear Chair DeFazio:

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U.S. Department
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800 Independence Ave., S.W.
Washington, DC 20591

March 31, 2022

The Honorable Sam Graves
Ranking Member
Committee on Transportation and Infrastructure
House of Representatives
Washington, DC 20515

Dear Ranking Member Graves:

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Sincerely,

Steve Dickson
Administrator

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FAA
Aviation Safety

REPORT TO CONGRESS:

AIRCRAFT CABIN EVACUATION PROCEDURES

FAA Reauthorization Act of 2018 (Public Law 115-254) — Section 337

Executive Summary

The Federal Aviation Administration (FAA) submits this report in accordance with Section 337 of the FAA Reauthorization Act of 2018[1] (the Act). Section 337, Aircraft Cabin Evacuation Procedures, requires the Administrator of the FAA to conduct a review of evacuation certification of transport-category aircraft used in air transportation, with regard to specific considerations and a review of recent accidents and incidents in which passengers evacuated such aircraft.

Section 337(b) of the Act requires that, in conducting these reviews, the FAA Administrator consult with the National Transportation Safety Board (NTSB), transport-category aircraft manufacturers, air carriers, and other relevant experts and Federal agencies, including groups representing passengers, airline crewmembers, maintenance employees, and emergency responders. It also mandates a review of all relevant data with respect to evacuation certification of transport-category aircraft. In accordance with Section 337(b), the FAA chartered the Emergency Evacuation Standards Aviation Rulemaking Committee (the ARC) to assist in carrying out the requirements of the Act.

This report summarizes the results of the FAA's review and related recommendations. The FAA concludes that the overall level of safety in evacuations is very high. In addition, evacuation events are extremely infrequent in proportion to the total number of flights that occur. Nonetheless, some areas for improvement remain, especially in terms of the requirements, guidance, and data collection used to evaluate evacuation standards and events, such as over-wing exits when no escape slide is provided, and the survivability and use of flightcrew communication systems in emergencies.

[1] Pub. L. 115-254 (Oct. 5, 2018).

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Legislative Mandate

Section 337 of the Act states as follows:

(a) REVIEW.—The Administrator of the Federal Aviation Administration shall review—

(1) evacuation certification of transport-category aircraft used in air transportation, with regard to—

(A) emergency conditions, including impacts into water;

(B) crew procedures used for evacuations under actual emergency conditions;

(C) any relevant changes to passenger demographics and legal requirements, including the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.), that affect emergency evacuations; and

(D) any relevant changes to passenger seating configurations, including changes to seat width, padding, reclining, size, pitch, leg room, and aisle width; and

(2) recent accidents and incidents in which passengers evacuated such aircraft.

(b) CONSULTATION; REVIEW OF DATA.—In conducting the review under subsection (a), the Administrator shall—

(1) consult with the National Transportation Safety Board, transport-category aircraft manufacturers, air carriers, and other relevant experts and Federal agencies, including groups representing passengers, airline crew members, maintenance employees, and emergency responders; and

(2) review relevant data with respect to evacuation certification of transport-category aircraft.

(c) REPORT TO CONGRESS.—Not later than 1 year after the date of enactment of this Act, the Administrator shall submit to the appropriate committees of Congress a report on the results of the review under subsection (a) and related recommendations, if any, including recommendations for revisions to the assumptions and methods used for assessing evacuation certification of transport-category aircraft.

Background

Evacuation safety involves multiple factors, grouped in three broad areas.

1. Occupant Protection (i.e., occupants are able to evacuate).
2. Time available for egress (i.e., conditions remain suitable for evacuation for as long as possible).
3. Speed of egress (i.e., occupants can evacuate as fast and safely as possible).

Section 337 mandates the FAA perform a two-part review. First, the FAA worked with the ARC to review evacuation certification standards and information concerning transport-category aircraft. Then, considering all three of the areas identified above, the FAA studied findings concerning accidents and incidents in which passengers evacuated such aircraft.

1) *Section 337(a)(1) Review of evacuation certification of transport-category aircraft:*

   The ARC reviewed evacuation certification of transport-category aircraft with respect to the considerations outlined in Section 337(a)(1)[2] and used the work of two recent FAA studies. One of these studies reviewed evacuation certification with respect to impacts onto water.[3] A separate study reviewed evacuation certification with regard to relevant changes to passenger seat spacing and size.[4] While the ARC did not duplicate these efforts, the FAA used the results of these studies for the purposes of this report.

2) *Section 337(a)(2) Review of recent accidents and incidents in which passengers evacuated such aircraft:*

   In addition to the Section 337(a)(1) review, the ARC studied recent accidents and incidents[5] ("evacuation events") in which passengers evacuated transport-category aircraft in accordance with Section 337(a)(2). The ARC identified more than 290 evacuation events in the last 10 years, the most recent of which occurred in November 2019. In the course of studying these 290-plus evacuation events, the ARC reviewed factors such as passenger behavior, which Section 337 does not explicitly require the FAA to study.

This report includes the results of this two-part review and related FAA recommendations.

[2] Appendix A lists the regulations the ARC reviewed.
[3] See Appendix E, Transport Airplane Crashworthiness and Ditching Working Group (TACDWG) Recommendation Report.
[4] See Appendix D, FAA Civil Aerospace Medical Institute (CAMI) Study final report.
[5] The NTSB did not classify many of the events the FAA and ARC reviewed as accidents or incidents according to NTSB definitions. See Title 49 of the Code Federal Regulations (Title 49) § 830.2. As a result, little data is available about these evacuation events.

Section 337 Review Results and Related FAA Recommendations

The two-part review resulted in the following general observations:

1. The large majority of evacuation events are successful, but areas for improvement exist.

2. With respect to evacuation certification of transport-category aircraft, there have been few "relevant changes to passenger demographics and legal requirements" as described in Section 337(a)(1)(C).

3. With respect to evacuation certification of transport-category aircraft, there have been no "relevant changes to passenger seating configurations, including changes to seat width, padding, reclining, size, pitch, leg room, and aisle width" as described in Section 337(a)(1)(D).

4. Many evacuations take place even though the flightcrew is aware that there is not an actual emergency.

5. Communication among the flightdeck and the cabin, the flightcrew and aircraft rescue and firefighting (ARFF), and flightcrew and passengers often is neither timely nor clear.

6. Passengers often are confused about the escape route when using exits over the wing, particularly when no escape slide is available.

7. With regard to assumptions and methods used in evaluating evacuation standards, no systematic process exists for gathering evacuation data from in-service events when the evacuation event is not classified as an accident, and therefore not formally investigated.[6]

8. With regard to assumptions and methods used in evaluating evacuation standards, regulatory standards that have prescriptive or dimensional requirements may become out of date as population demographics or technologies evolve.

While there was a noticeable increase in passenger load factor from 2002-2010, the load factor remained relatively constant from 2010-2020 when the events that the ARC

[6] Title 49 CFR § 830.2 provides, "*Aircraft accident* means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage." Given this limited definition, official, documented investigations of certain evacuation events might not occur. As a result, little data and information is available about many events.

reviewed took place. The vast majority of evacuations that occurred as a result of such events were successful.

Additional Review Items

In addition to the issues that emerged from its review of in-service information and NTSB recommendations, the ARC considered factors identified by the FAA as potentially affecting an evacuation. While Section 337 does not require this report to address these items, the FAA acknowledges various other factors the ARC considered. Table 1 lists these factors.

Table 1: Other Emergency Evacuation Factors

No.	Issue	Disposition after discussion
1	Service or emotional support animals	Not identified as an issue in any of the events reviewed. The ARC had no recommendation on this subject.
2	Passenger load factors	Not identified as an issue in any of the events reviewed. The ARC had no recommendation on this subject.
3	Seat spacing*	Evaluated by CAMI.
4	Passenger anthropometry*	Evaluated by CAMI.
5	Quantity of carry-on baggage	Observed in the events reviewed and the subject of an ARC recommendation.
6	Family groups being separated	Not identified as an issue in any of the events reviewed. The ARC had no recommendation on this subject.
7	Electronic device/entertainment distractions	Not identified as an issue in any of the events reviewed. The ARC had no recommendation on this subject.
8	Passenger age and disabilities*	Not identified as an issue in any of the events reviewed. The ARC had no recommendation on this subject.
9	Unoccupied exit seating	Not identified as an issue in any of the events reviewed. Subject of a separate report to Congress.[7]
10	Lack of systematic data collection on evacuation events	This was a finding and recommendation by the ARC. The

[7] See section 323 of the Act ("Exit Rows").
*Consideration of this is required by statute in § 337(a)(1)

No.	Issue	Disposition after discussion
		FAA intends to implement a system to capture data regularly and use that information to assess the requirements.

The FAA determined only two of the above factors were directly relevant to the review of in-service events. These factors were: item 5 (passengers frequently take carry-on baggage in an evacuation) and item 10 (there is no systematic collection of data for evacuation events). For items 3 and 4, CAMI analyzed data from its study of the impact of seat spacing on egress.[8] The study includes an assessment of participant anthropometry as compared with the national averages. See Appendix D, FAA Civil Aerospace Medical Institute (CAMI) Study final report.

After completing the review under Section 337 in consultation with industry experts and stakeholders, the FAA considered a number of recommendations, including those from the ARC. The FAA makes 12 final recommendations, described below.[9]

FAA Recommendation #1

Finding: Based on a review of the evacuations that occurred through over-wing exits, some evacuees do not understand where or how to egress from a wing when no escape slide is provided. A review of the applicable regulations and guidance reveals potential for improvement because, although the flightcrew shows evacuees the escape route, evacuees need additional information to transition from the wing to the ground safely.

Section 25.810(c) ("Emergency egress assist means and escape routes") addresses the creation of the escape route on the wing with respect to width and contrast ratio. Section 25.813(c)(3)(ii) addresses instructions on how to open the exit, but does not provide guidance to indicate where an evacuee should go after the exit is opened.

Section 25.810(d) mandates the installation of a means to assist evacuees if the place on the wing at which the escape route required by Section 25.810(c) terminates is more than six feet from the ground with the aircraft on the ground and the landing gear extended.

Recommendation: The FAA recommends conducting, in coordination with other aviation authorities, a review of the requirements for marking the escape routes for

[8] The CAMI test parameters were chosen for the purpose of isolating the effects of seat size and spacing. FAA recognizes that the CAMI tests relied on able-bodied adult subjects under age 60, consistent with regulatory and ethical standards for human testing. As a result, the tests provide useful, but not necessarily definitive information, regarding the effects of seat dimensions on safe evacuations for all populations.

[9] The FAA did not conduct a cost-benefit analysis for any recommendations included in this Report. If the FAA makes regulatory changes, the FAA envisions working with experts to develop standards, as appropriate, and completing rulemaking. As a result, final implementation of any recommendation could differ from the recommendation described in this Report.

over-wing exits in Section 25.810 to determine what actions are necessary to improve passenger recognition and allow for transition from the wing to the ground in a manner that is faster and safer than the current types of transitions.

FAA Recommendation #2

Finding: Of the 290 aircraft evacuation events the ARC reviewed, approximately 25 percent involved an aircraft at a non-normal attitude, due to the loss of one or more legs of landing gear. After reviewing the pertinent regulations and guidance, the ARC determined the condition is addressed by the regulations.

However, the ARC also discovered that guidance is unavailable regarding how airframe manufacturers should establish the aircraft adverse attitudes and exit sill heights corresponding to the loss of one or more legs of landing gear. Through its discussions, the ARC discovered that, due to the lack of FAA guidance or industry consensus standards, differences exist in the assumptions airframe manufacturers use to establish the aircraft adverse attitudes and exit sill heights.

Recommendation: The FAA recommends updating guidance for determining aircraft attitudes and measuring sill heights corresponding to the loss of one or more legs of landing gear.[10]

FAA Recommendation #3

Finding: Due to the lack of information on survival aspects in some of the events the ARC reviewed, it is not clear how many cases of poor communication resulted from either a failure of the communication or public address systems or difficulty in the use of communication handsets. The ARC learned that for some events, the communication system and public address systems were inoperative as a result of aircraft damage. In at least one accident, crewmembers experienced difficulty in using the communication handsets, due to unfamiliarity with them.

Some airlines use a variety of communication handset designs within their fleet. When crewmembers are under severe pressure, their lack of familiarity with a handset compromised their ability to use the communication system.

Recommendation: The FAA recommends conducting a review of Sections 25.1362 (“Electrical supplies for emergency conditions”), 25.1423 (“Public address system”), and 121.319 (“Crewmember interphone system”) to ensure the regulations adequately cover all aspects of the survivability and use of flightcrew communication systems. The FAA also recommends evaluating standards for communication system handsets and considering standardization of handsets for communication systems for all aircraft types.

[10] Transport Aircraft Cabin Interiors Crashworthiness Handbook (May 18, 2009), *available at* https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/74596.

FAA Recommendation #4

Finding: In the aircraft evacuation events reviewed, the ARC concluded the overall performance of the escape slides was satisfactory. Therefore, the finding did not result in specific recommendations for regulatory changes to improve performance. However, when reviewing the pertinent regulations and guidance, the ARC determined that inconsistencies exist in the requirements for escape slides that are provided for non-over-wing and over-wing exits.

Through its discussions, the ARC determined that while there are inconsistencies in the requirements, airframe manufacturers and escape slide suppliers consistently demonstrate compliance for non-over-wing and over-wing escape slides. The guidance AC 25-17A provides also suggests consistency should exist in the means to comply with Section 25.810(a)(1) and (d).

Recommendation: The FAA recommends considering revisions to Section 25.810(d) to make the requirements for off-wing assist means (escape slides) consistent with those in Section 25.810(a), which applies to assist means used at non-over-wing exits.

FAA Recommendation #5

Finding: The FAA promulgated requirements for emergency lighting in 1967. The requirement for illumination level for exit signs and for cabin emergency lighting on transport-category aircraft has not changed since this amendment.

The illumination technologies used 40 years ago, such as incandescent lighting, are different from the technologies used today, such as light emitting diodes. The industry has evolved, without any regulatory changes, and all aircraft delivered today have an emergency lighting system and illuminated exit signs with a performance well above the minimum requirements. In many cases, lighting is now an order of magnitude brighter. The same is true for evacuation slide lighting.

Improving the required levels of minimum illumination would be an effective way to achieve an effective level of performance of state-of-the-art emergency lighting systems, which the FAA has recently certified for installation on large aircraft. Such improvement would not burden the industry, as existing systems still would be compliant. Moreover, doing so would prevent an applicant for a new aircraft type from designing an emergency lighting system with a questionable performance level.

Because the applicable requirement already provides for dispatch relief, the FAA considered whether amending the standards would reduce the existing flexibility that dispatch relief affords. Given that the goal is to neither go beyond what exists today, nor mandate a retrofit, increasing the standards would not prompt a new burden or remove flexibility.

Recommendation: The FAA recommends examining the existing requirements applicable to emergency lighting systems of transport category airplanes to determine whether the FAA should mandate higher illumination levels consistent with current state-of-the-art lighting systems.

FAA Recommendation #6

Finding: Of the 290 aircraft evacuation events the ARC reviewed, approximately 16 percent involved evacuations using Type III over-wing exits, which Section 25.807(a)(3) defines, in part, as "a rectangular opening of not less than 20 inches wide by 36 inches high with corner radii not greater than seven inches, and with a step-up inside the airplane of not more than 20 inches." The ARC observed that when the Type III exit is a removable hatch, persons using the hatch did not dispose of the hatch out of the egress path of evacuees in a consistent manner, although Section 25.813(c)(iii) requires placards to indicate an appropriate location to place the hatch after removal. Placing the hatch in the Type III exit area—either on seats adjacent to the exit, in the passageway leading to the exit, or on the wing—potentially increases the difficulty of egress through the Type III exit or introduces an obstacle in the escape route on the wing required by Section 25.810(c). Such difficulty might delay evacuation.

With Certification Specification (CS) 25.813, amendment 9, the European Union Aviation Safety Authority (EASA) introduced the concept of the Automatically Disposable Hatch (ADH).[11] When this hatch is fully opened, it automatically must go to a position that will not reduce the size of the exit opening or the passageway(s) leading to the exit below their minimum required dimensions. It also must not obstruct egress from the exit via the escape route specified in EASA CS 25.810.

Section 25.813(c)(3)(iii) ("Emergency exit access") states, "if the exit is a removable hatch, state the weight of the hatch and indicate an appropriate location to place the hatch after removal." In comparison, EASA CS 25.813(c)(6) states:

> Each Type III exit must be designed such that when operated to the fully open position, the hatch/door is automatically disposed so that it can neither reduce the size of the exit opening, the passageway(s) leading to the exit, nor the unobstructed space specified in sub-paragraph I(2)(ii) of this paragraph, to below the required minimum dimensions. In the fully open position it must also not obstruct egress from the exit via the escape route specified in CS 25.810(c).

Recommendation: The FAA recommends reviewing Section 25.813(c) further to determine whether it should harmonize the regulation with EASA CS 25.813(c) or whether the FAA can accomplish the objective of EASA CS 25.813(c) by other means.

FAA Recommendation #7

Finding: Within the accident set reviewed, the ARC observed at least two common negative trends related to flightcrew operation before or during the initiation of the emergency evacuation:

[11] EASA Certification Specifications For Large Aeroplanes CS-25 Amendment 9 (August 5, 2010), *available at* https://www.easa.europa.eu/sites/default/files/dfu/CS-25%20Amendment%209.pdf.

- The complexity of applicable Non-Normal Checklist(s) and the Emergency Evacuation Checklist led to delays in rendering the aircraft safe for the initiation or completion of the emergency evacuation.
- The physical execution of an emergency evacuation (exiting the aircraft) is challenging.

The ARC determined many of the evacuations it studied could have occurred more efficiently and expeditiously if crewmembers had additional training concerning emergency evacuation scenarios.

Recommendation: The FAA recommends completing research and promoting essential actions for crewmembers to perform during an actual or potential emergency evacuation scenario and, based on the results of this review, as appropriate, issue guidance for:

1. Aircraft manufacturers to review and revise, as necessary, the Emergency Evacuation Checklist to ensure the actions included on the Checklist are logical, necessary, and appropriately ordered.
2. Aircraft operators to—
    - Revise the applicable Emergency Evacuation Checklist to align with manufacturer guidance;
    - Revise procedures to align with industry best practices and FAA research, as described above;
    - Update emergency procedures to remove ambiguity concerning the decision to initiate, continue, or stop an emergency evacuation;
    - Ensure appropriate crewmembers complete initial and recurrent emergency evacuation training incorporating the findings of the FAA's review.

<u>FAA Recommendation #8</u>

Finding: In 18 of the 290-plus events reviewed, many of which occurred recently, operators decided to use the emergency escape systems to unload the aircraft in a non-emergency manner. These non-urgent evacuations often are labeled as "rapid disembarkations." The use of escape systems that are designed to unload in urgent situations to unload the aircraft at a modest rate poses safety concerns. Operators might intend this form of evacuation to minimize the number of injuries that might arise from the use of slides during events that present, in the judgment of the flightcrew, a less than imminent threat to the health and safety of the aircraft's occupants, or there may be other reasons for these rapid disembarkations. Unfortunately, the reports of these incidents, which generally are superficial because these evacuations rarely lead to full investigations, lack sufficient detail of underlying factors. These evacuations generally occur away from the gate and do not involve the full and aggressive use of crewmember commands and emergency egress equipment. This category of events occurs frequently, indicating the need to improve the FAA's understanding of the circumstances and decision-making involved.

Recommendation: The FAA recommends that, in coordination with other aviation authorities and aircraft accident investigative agencies, it collect, catalogue, and analyze non-urgent evacuations to improve its understanding of the decision-making processes that lead to these events. Based on the results of this recommended review, the FAA might issue guidance to inform potential improvements to operator procedures.

FAA Recommendation #9

Finding: In its June 2000 safety study titled Emergency Evacuation of Commercial Airplanes, the NTSB stated passengers attempting to take their carry-on baggage during an evacuation interrupted the flow of the evacuation by stopping to retrieve bags from overhead bins. The report also stated that flight attendants reported that they attempted to take carry-on bags from passengers before exiting an aircraft during an emergency. Subsequent accident investigations by the NTSB indicate concern about passengers taking carry-on baggage with them during an emergency evacuation. The ARC's review of 290 evacuation events noted several examples of passengers retrieving carry-on baggage during an evacuation. However, many reports that the ARC reviewed lacked details, such as information about baggage.

No clear examples existed in the accidents the ARC reviewed that noted a measured delay in the evacuation time due to passengers taking carry-on bags with them during the evacuation. Nonetheless, the FAA recognizes that delays that result from passengers retrieving carry-on baggage could introduce risk.

Some air carriers' pre-flight safety briefings currently include statements reminding passengers that in the event of an emergency, passengers should leave all carry-on baggage on the aircraft, but some briefings do not include these statements.

Recommendation: Guidance or oversight by the FAA should address the lack of uniformity in instructions about taking carry-on baggage during an emergency. As an unplanned emergency evacuation can occur either on takeoff or landing, improved briefings should apply to both pre-takeoff and pre-landing announcements.

The FAA recommends revising Advisory Circular 121-24D, titled "Passenger Safety Information Briefing and Briefing Card" to include a new paragraph recommending that pre-flight safety announcements and pre-landing safety announcements include instructions that all carry-on baggage is left on the aircraft if an emergency occurs during either takeoff or landing.[12]

FAA Recommendation #10

Finding: Of the aircraft evacuation events the ARC reviewed, up to eight of them occurred or began with at least one engine running. The FAA and EASA have long considered engines running during an emergency evacuation to be a foreseeable event. As a result, various means of compliance (MOC) issue papers and certification review items have addressed the problem of the engine running as part of the certification of

[12] Passenger Safety Information Briefing and Briefing Cards (Mar. 5, 2019), *available at* https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_121-24D.pdf.

escape slides positioned in close proximity to an engine inlet. The FAA's process for reviewing such MOC issue papers and certification review items includes evaluating airframe and escape slide manufacturers' demonstrations of the escape slide. During this review, the FAA confirms that the mechanism provides for safe evacuation in a 25-knot wind combined with the effects of the engine running at ground-idle. EASA recently adopted an explicit requirement and associated guidance in CS 25.810, amendment 18, meaning the current FAA rule is not consistent with CS 25.810.

Recommendation: The FAA recommends reviewing Section 25.810(a)(1)(iv) to determine whether it should require the 25-knot wind standard be combined with the effects of an engine running at ground idle for the certification of an escape slide in close proximity to the engine inlet. The FAA may also examine other means to fulfill this intent.

FAA Recommendation #11

Finding: As discussed above, many evacuation requirements are intended to address scenarios for which a straightforward performance standard is not readily available. In those cases, the requirements often specify dimensions meant to address both the demographics and anthropometry of the flying public, as well as situations too hazardous to test with human subjects. Examples of these requirements include aisle width, passageway dimensions, exit opening sizes, and the prescriptive standards for flight attendant staffing. The FAA intended these requirements to provide adequate provisions for egress, considering a range of occupant sizes, under varying conditions where rapid egress is essential, e.g., when a fire occurs or the aircraft is not on all its landing gear. Due to the difficulty in maintaining standardization and evolving demographics, the FAA has not characterized requirements based on dimensions as performance standards. In addition, guidance exists for certain dimension parameters that are based on the anthropometry of the population at a given time (e.g., flight attendant seat size). Such guidance would benefit from a periodic review against the current population.

Recommendation: The FAA recommends implementing a process for periodic review of evacuation-related standards that are based on demographics and anthropometry, such that as those characteristics evolve, the FAA can anticipate the need for changes to the requirements and update the requirements when necessary. This includes regulatory requirements such as those for aisle width and exit size, as well as guidance for dimensions of seat and assist spaces.

FAA Recommendation #12

Finding: Collection of specific information from investigations of accidents or incidents will prompt improvements to aviation safety. Despite the ability to use resources available to the NTSB, the ARC found it difficult to obtain specific details regarding many of the 290 evacuation events. For many of the events, official investigative reports were unavailable and the events were referenced only in the media. It is unclear whether this lack of information is because the relevant authority had not completed its investigation or the relevant authority had not initiated an investigation. If the event did

not rise to the level of an accident as defined by the NTSB, little data was available. Safety studies that have the goal of preventing accidents and incidents and improving the survivability of occupants often rely on detailed information from investigative reports.

The ARC would have benefited from complete documentation of the 290 evacuation events and the FAA would benefit from information and analysis of actual or potential safety deficiencies. Additional and detailed information also would support future studies regarding aircraft evacuation safety certification and procedures. Multiple resources exist to support uniform collection of information in the United States and abroad.

Both the International Civil Aviation Organization (ICAO) and the NTSB have tools and recommendations to collect information missing in most of the events. For example, ICAO uses the Manual on the Investigation of Cabin Safety Aspects in Accidents and Incidents (Doc 10062) to encourage the uniform application of the Standards and Recommended Practices contained in Annex 13, particularly regarding accident survival aspects. Similarly, the NTSB encourages uniform collection of information and investigations to improve transportation safety and provides a suggested template for collecting information related to survival factors. However, neither of these tools applies if no formal investigation occurs.

Recommendation: The FAA recommends using available data-gathering tools to work with organizations, companies, and individuals to improve evacuation certification and procedures through comprehensive data collection and analysis. Additional data will help identify survival factors in aviation accidents and incidents involving evacuation and will contribute to the periodic review of relevant requirements.

Conclusion

The overall level of safety and likelihood of survivability in events involving evacuations is very high. Based on available data, there are approximately 30 evacuation events per year worldwide out of more than 10 million scheduled passenger flights per year in the U.S. alone. No evacuation-related fatalities in the U.S. occurred during the ten-year period covered by the ARC's review.[13] Due to regulatory advancements and improvements in materials and training, the safety of commercial aircraft has improved with regard to evacuation and occupant protection. Nonetheless, the FAA recognizes that the factors affecting evacuation are continually evolving and several areas for improvement exist.

[13] The ARC completed its review in March 2020.

Appendix A: Evacuation-Related Regulatory Requirements and Advisory Material

Section 25.561(c)(1)(iii) and (d) "General"

Section 25.562(c)(8), "Emergency landing dynamic conditions."
Guidance: AC 25.562-1B, "Dynamic Evaluation of Seat Restraint Systems and Occupant Protection on Transport Aircrafts"

Section 25.735(g), "Brakes and braking systems."

Section 25.793, "Floor surfaces."

Section 25.801, "Ditching."

Section 25.803, "Emergency evacuation."
Guidance: AC 25.803-1A, "Emergency Evacuation Demonstrations"

Appendix J to Part 25—Emergency Evacuation

Section 25.807, "Emergency exits."

Section 25.809, "Emergency exit arrangement."

Section 25.810, "Emergency egress assist means and escape routes."

Section 25.811, "Emergency exit marking."

Section 25.812, "Emergency lighting."
Guidance: AC 25.812-1A, "Floor Proximity Emergency Escape Path," and AC 25.812-2, "Floor Proximity Emergency Escape Path Marking Systems Incorporating Photoluminescent Elements"

Section 25.813, "Emergency exit access."

Section 25.815, "Width of aisle."

Section 25.817, "Maximum number of seats abreast."

Section 25.851(b)(2), "Fire extinguishers."

Section 121.291, "Demonstration of emergency evacuation procedures."

Appendix D to Part 121—Criteria for Demonstration of Emergency Evacuation Procedures Under Section 121.291

Section 121.309, "Emergency equipment."

Section 121.310, "Additional emergency equipment."

Section 121.311, "Seats, safety belts, and shoulder harnesses."

Section 121.319, "Crewmember interphone system."

Section 121.391, "Flight attendants."

Section 121.393, "Crewmember requirements at stops where passengers remain on board."

Section 121.394, “Flight attendant requirements during passenger boarding and deplaning.”

Section 121.397, “Emergency and emergency evacuation duties.”

Section 121.417, “Crewmember emergency training.”

Section 121.421, “Flight attendants: Initial and transition ground training.”

Section 121.570, “Airplane evacuation capability.”

Section 121.571, “Briefing passengers before takeoff.”

Section 121.585, “Exit seating.”

Advisory Circulars (ACs):

AC 25-17A	Transport Aircraft Cabin Interiors Crashworthiness Handbook
AC 25.562-1B	Dynamic Evaluation of Seat Restraint Systems and Occupant Protection on Transport Aircrafts
AC 25.785-1B	Flight Attendant Seat and Torso Restraint System Installations
AC 25.803-1A	Emergency Evacuation Demonstrations
AC 25.807-1	Uniform Distribution of Exits
AC 25.812-1	Floor Proximity Emergency Escape Path Marking
AC 25.812-2	Floor Proximity Emergency Escape Path Marking Systems Incorporating Photoluminescent Elements
AC 120-47	Survival Equipment for use in Overwater Operations
AC 120-48A	Communication and Coordination Between Flightcrew Members and Flight Attendants
AC 121-24D	Passenger Safety Information Briefing and Briefing Cards
AC 121-29B	Carry-On Baggage

Appendix B: ARC Recommendations that Did Not Result in Action

EES-1. The ARC recommends the FAA establish a working group to document cause(s) for smoke/fume issues and develop corrective actions that will prevent or minimize smoke/fume events and consider effects on passengers as well (to the extent that it affects evacuation).

FAA Assessment: Some events involving smoke/fume issues might lead to evacuations. The FAA already has ongoing efforts to assess in-flight smoke/fume events, for their primary effects on occupants.

EES-6. The ARC recommends the FAA review the Continuous Analysis and Surveillance System data and other data sources and determine if the fire detection system failure rate warrants a corrective action plan.

FAA Assessment: The FAA has ongoing research efforts to explore improved fire detection systems. Because a fire detection system must detect every fire (i.e., avoid any failure to detect a fire), and because the probability of a fire is extremely low, there will always be a greater number of false alarms than actual fires. The FAA continues to work with industry to establish criteria for improved fire detectors.

EES-10. The ARC recommends the FAA ensure flight attendants who conduct an evacuation demonstration for an original equipment manufacturer use emergency evacuation procedures valid for foreseeable evacuation scenarios.

FAA Assessment: This is already part of the FAA's certification and operational approval process.

EES-12. The ARC recommends the FAA evaluate the staffing requirements of § 121.391 to determine if any updates are needed, including whether to amend § 121.391(a).

FAA Assessment: This review was essentially conducted during the ARC's work, and did not identify current flight attendant staffing is inadequate. However, in keeping with the FAA's action to periodically assess prescriptive standards, the FAA will assess the requirements for flight attendant staffing on a regular basis.

EES-13. The ARC recommends the FAA revise AC 121-24D Appendix 1(6)(a)2, "Exit Seating."

FAA Assessment: The FAA will submit a separate report to Congress that addresses this subject to satisfy Section 323 of the Act ("Exit Rows").

EES-22. The ARC recommends the FAA adopt the sub-team 4 (Equipage) recommendations in the TACDWG report to the FAA, dated September 20, 2018, pertaining to the above items and the recommendation pertaining to the emergency equipment and its associated guidance material.

FAA Assessment: The FAA's review and process of the Crashworthiness and Ditching Working Group's recommendations is underway and no separate actions are required.

EES-5. The ARC recommends the FAA amend AC 150/5210-17C, section 1.3.6 "Training Curriculum (Application of Extinguishing Agents)."

EES-14. The ARC recommends the FAA establish a universal designated emergency radio frequency (such as 121.500) at all airports certified under 14 CFR part 139 and amend AC 150/5210-7D (or current revision) to ensure flightcrew, ARFF personnel, and air traffic control personnel are aware of its designation.

EES-23. The ARC recommends the FAA amend § 139.317 to require a mobile stair truck vehicle with sufficient reach to aircraft cabin doors to allow safe and organized deplaning of passengers and crew and/or to allow rapid entry into aircraft by fire suppression and rescue personnel at all § 139.315 Index B, C, D and E airports.

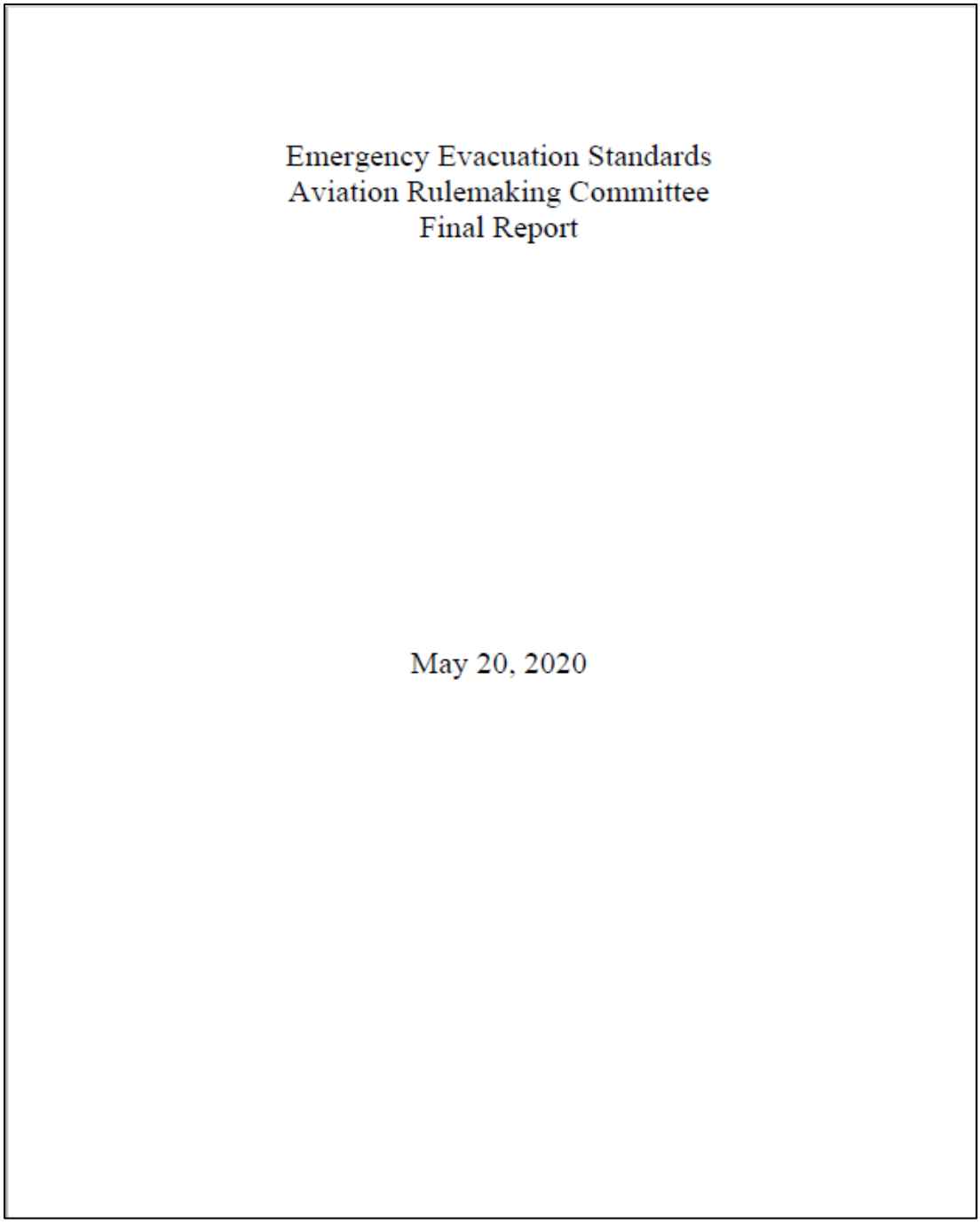
EES-24. The ARC recommends the FAA act on the recommendations contained in the ARFF Requirement Working Group (ARFFRWG) and ARFF Working Group reports and National Fire Protection Association (NFPA) Standard 403.

EES-25. The ARC recommends the FAA modernize ARFF services at U.S. airports by amending and updating § 139.315, "Aircraft rescue and firefighting: Index determination;" § 139.317, "Aircraft rescue and firefighting: Equipment and agents;" and § 139.319, "Aircraft rescue and firefighting: Operational requirements." The ARC also recommends the FAA review the ARFFRWG final report submitted to the FAA in March 2004 and incorporate relevant NFPA Standards (see below) as they pertain to ARFF services.

EES-26. The ARC recommends the FAA consider including cargo operations as part of the overall airport response to an aircraft accident as applicable to 14 CFR part 139 to ensure one level of safety for all occupants onboard cargo operations.

FAA Assessment: Recommendations EES-5, -14, and -23 through -25 all pertain to ground-based Aircraft Rescue and Fire Fighting. Recommendation EES-14 also involves air traffic communications. Although these issues arose from the ARC's review of in-service events, the ARC membership consisted of aircraft design, certification, and operations experts, as per the direction in Section 337 of the Act. Thus, the makeup of the ARC did not fully represent the ARFF community. While these recommendations may have merit, further staffing is required to assess the relative benefits of the recommendations, in the context of other safety initiatives, and the impact that implementation of these recommendations would have.

Appendix C: The Emergency Evacuation Standards Aviation Rulemaking Committee (ARC) Final Report[14]


Emergency Evacuation Standards
Aviation Rulemaking Committee
Final Report

May 20, 2020

[14] A copy of the ARC Final Report is available at https://www.faa.gov/regulations_policies/rulemaking/committees/documents/

Appendix D: Civil Aerospace Medical Institute (CAMI) Final Report[15]

Federal Aviation Administration

DOT/FAA/AM-21/01
Office of Aerospace Medicine
Washington, DC 20591

Effects of Airplane Cabin Interiors on Egress I: Assessment of Anthropometrics, Seat Pitch, and Seat Width on Egress

David B. Weed
Melissa S. Beben
David J. Ruppel
Kelly J. Guinn
Susan M. Jay

Civil Aerospace Medical Institute
Federal Aviation Administration
Oklahoma City, OK 73125

January 2021

Final Report

[15] A copy of the CAMI Final Report is available at https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2020s/2022/

Appendix E: Transport Airplane Crashworthiness and Ditching Working Group (TACDWG) Final Report[16]

October 22, 2018

Ms. Lirio Liu
Director, Office of Rulemaking
Designated Federal Official for the Aviation Rulemaking Advisory Committee
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

RE: Transport Airplane Crashworthiness and Ditching Working Group Recommendation Report; Approved Direction of ARAC at September 20, 2018, Meeting

Dear Ms. Liu,

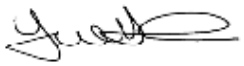
Attached is the Recommendation Report of the Transport Airplane Crashworthiness and Ditching Working Group (TACDWG), a Working Group established under the Transport Airplane and Engine (TAE) Subcommittee. This report was approved by the Aviation Rulemaking Advisory Committee (ARAC) on September 20, 2018, in accordance with the following stipulations:

1. Pages 2-3 of the report submitted to ARAC prior to the September 20, 2018, meeting were directed by ARAC to be removed.
2. The record was ordered to be kept open until October 20, 2018, to allow for the Association of Flight Attendants (AFA) to submit a dissent to the report's Executive Summary.
3. The AFA's dissent was ordered to be inserted into the report directly after the report's Executive Summary.

I have confirmed the actions directed by ARAC have been followed, therefore, on behalf of the ARAC members, please accept the attached TACDWG Recommendation Report and forward it to the relevant program offices within the Federal Aviation Administration (FAA). Please also accept the TACDWG's report as completion of its tasking, *See* 80 Fed. Reg. 31946 (June 4, 2015).

Please do not hesitate to contact me with any questions. Thank you very much.

Sincerely yours,



Yvette A. Rose
ARAC Chair

cc: David Oord, ARAC Vice Chair
Kevin Davis, Boeing, TACDWG Chair
Keith Morgan, Pratt & Whitney, TAE Chair
Chris Witkowski, Association of Flight Attendants, ARAC Member

[16] A copy of the TACDWG Report is available at https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/ARAC-TACDWG_FAA_Report-Final_September20_2018ARAC%20W%20AFA%20DISSENT.pdf.